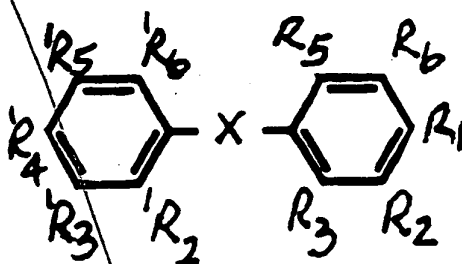


1 WHAT IS CLAIMED IS:

2
3 1. A method of modulating the activity of a thyroid hormone receptor (TR) which
4 comprises administering to a mammal in need thereof a compound of the formula:



11 wherein said compound fits spatially and preferentially into a TR ligand binding
12 domain (TR LBD) and comprises the following substituents:

13 (i) an R1-substituent comprising an anionic group that interacts with a side chain
14 nitrogen atom of an arginine corresponding to a residue selected from the group consisting of
15 Arg228, Arg262, and Arg266 of human TR- α , and Arg282, Arg316 and Arg320 of human
16 TR- β , and wherein the anionic group is 1.7-4.0Å from the nitrogen atom;

17 (ii) an R2-substituent comprising a hydrophobic or hydrophilic group that fits
18 spatially into the TR LBD;

19 (iii) an R3-substituent comprising a hydrophobic or hydrophilic group that
20 interacts with a side chain atom of a serine, alanine or isoleucine corresponding to a residue
21 selected from the group consisting of Ser260, Ala263 and Ile299 of human TR- α , and
22 Ser314, Ala317 and Ile352 of human TR- β , and wherein the hydrophobic or hydrophilic
23 group is 1.7-4.0Å from the side chain atom;

- 1 (iv) an R5-substituent comprising a hydrophobic or hydrophilic group that interacts
2 with a side chain atom of a phenylalanine or isoleucine corresponding to a residue selected
3 from the group consisting of Phe218, Ile221 and Ile222 of human TR- α , and Phe272, Ile275
4 and Ile276 of human TR- β , and wherein the hydrophobic or hydrophilic group is 1.7-4.0Å
5 from the side chain atom;
- 6 (v) an R6-substituent comprising a hydrophobic or hydrophilic group that fits
7 spacially into the TR LBD;
- 8 (vi) an X-substituent comprising a hydrophobic or hydrophilic group that interacts
9 with a side chain atom of a leucine corresponding to a residue selected from the group
10 consisting of Leu276 and Leu292 of human TR- α , and Leu 330 and Leu346 of human TR- β ,
11 and wherein the hydrophobic or hydrophilic group is 1.7-4.0Å from the side chain atom;
- 12 (vii) an R2'-substituent comprising a hydrophobic or hydrophilic group that fits
13 spacially into the TR LBD;
- 14 (viii) an R3'-substituent comprising a hydrophobic group that interacts with a side
15 chain atom of a phenylalanine, glycine or methionine corresponding to a residue selected
16 from the group consisting of Phe215, Gly290, and Met388 of human TR- α , and Phe269,
17 Gly344, Met442 of human TR- β , and wherein the hydrophobic group is 1.7-4.0Å from the
18 side chain atom;
- 19 (ix) an R4'-substituent comprising an hydrogen bond donor or acceptor group that
20 interacts with a side chain carbon or nitrogen atom of a histidine corresponding to residue
21 His381 of human TR- α , and His435 of human TR- β , and wherein the hydrogen bond donor
22 or acceptor group is 1.7-4.0Å from the side chain atom;

1 (x) an R5'-substituent comprising a hydrophobic or hydrophilic group that fits
2 spacially into the TR LBD;

3 (xi) and R6'-substituent comprising a hydrophobic or hydrophilic group that fits
4 spacially into the TR LBD;

5 wherein said compound is other than a thyronine or thyronine-like compound
6 disclosed in a reference cited in Appendix I, and wherein the activity of said TR is
7 modulated.

8
9 2. The method according to claim 1,

10 wherein R₁ is

11 -O-CH₂CO₂H, -NHCH₂CO₂H,
12 -CO₂H, -CH₂CO₂H, -CH₂CH₂CO₂H, -CH₂CH₂CH₂CO₂H,
13 -CH₂CH(NH₂)CO₂H, -CH₂CH[NHCOCH₂]₂CO₂H, -CH₂CH[NHCO(CH₂)₁₅CH₃
14]CO₂H, -CH₂CH[NH-FMOC]CO₂H, -CH₂CH[NH-tBOC]CO₂H, or a carboxylate
15 connected to the ring with a 0 to 3 carbon linker,

16
17 -PO₃H₂, -CH₂PO₃H₂, -CH₂CH₂PO₃H₂, -CH₂CHNH₂PO₃H₂,
18 -CH₂CH[NHCOCH₂]₂PO₃H₂, -CH₂CH[NHCO(CH₂)₁₅CH₃]PO₃H₂,
19 -CH₂CH[NH-FMOC]PO₃H₂, -CH₂CH[NH-tBOC]PO₃H₂, or a phosphate or
20 phosphonate connected to the ring with a 0 to 3 carbon linker,

21
22 -SO₃H, -CH₂SO₃H, -CH₂CH₂SO₃H, -CH₂CHNH₂SO₃H, -CH₂CH[NHCOCH₂]₂SO₃H,
23 -CH₂CH[NHCO(CH₂)₁₅CH₃]SO₃H, -CH₂CH[NH-FMOC]SO₃H, -CH₂

1 CH[NH-tBOC]SO₃H, or a sulfate or sulfite connected to the ring with a 0 to 3 carbon
2 linker,

3
4 or acts as the functional equivalent of CH₂CH(NH₂)CO₂H of T3 in the molecular
5 recognition domain when bound to a TR, wherein said R₁ can be optionally
6 substituted with an amine,

7
8 wherein R₂ is

9 H, halogen, CF₃, OH, NH₂, SH, CH₃, -Et,

10 or acts as the functional equivalent of H in the molecular recognition domain when
11 bound to a TR,

12
13 wherein R₃ is

14 -H, halogen, -CF₃, -OH, -NH₂, -N₃, -SH, -CH₃, -Et,

15 or acts as the functional equivalent of I in the molecular recognition domain when
16 bound to a TR,

17
18 wherein R₅ is

19 -H, halogen, -CF₃, -OH, -NH₂, -N₃, -SH, -CH₃, -Et, or acts as the functional

20 equivalent of I in the molecular recognition domain when bound to a TR, and R₃ can

21 be identical to R₅,

22
23 wherein R₆ is

1 -H, halogen, -CF₃, -OH, -NH₂, -SH, -CH₃, or acts as the functional equivalent of H
2 in the molecular recognition domain when bound to a TR, and R₂ can be identical to
3 R₆,
4

5 wherein R₂' is

6 -H, halogen, -CF₃, -OH, -NH₂, -N₃, -SH, -CH₃, -Et, or acts as the functional
7 equivalent of H in the molecular recognition domain when bound to a TR,
8

9 wherein R₃' is any hydrophobic group, including

10 halogen, -CF₃, -SH, alkyl, aryl, 5- or 6-membered heterocyclic, cyano, or acts as the
11 functional equivalent of I in the molecular recognition domain when bound to a TR,
12

13 wherein R₄' is

14 -H, halogen, -CF₃, -OH, -NH₂, NH₃, -N(CH₃)₃, carboxylate, phosphonate, phosphate
15 or sulfate, -SH, -CH₃, -Et, or alkyl, aryl or 5- or 6-membered heterocyclic aromatic
16 attached through urea or carbamate linkages to O or N or S at the R₄' position, or
17 acts as the functional equivalent of OH in the molecular recognition domain when
18 bound to a TR,
19

20 wherein R₅' is

21 -H, -OH, -NH₂, -N(CH₃)₂, -SH, -NH₃, -N(CH₃)₃, carboxylate, phosphonate, phosphate,
22 sulfate, branched or straight chain alkyl having 1 to 9 carbons, substituted or
23 unsubstituted aryl, wherein said substituted aryl is substituted with halogen or 1 to 5

1 carbon alkyl and wherein said aryl is optionally connected to the ring by a -CH₂-,
2 aromatic heterocycle having 5 to 6 atoms, wherein said heterocycle may be substituted
3 with one or more groups selected from -OH, -NH₂, -SH, -NH₃, -N(CH₃)₃,
4 carboxylate, phosphonate, phosphate or sulfate, heteroalkyl, arylalkyl, heteroaryl
5 alkyl, polyaromatic, or polyheteroaromatic, wherein said R₅' may be substituted with
6 polar or charged groups,

7
8 wherein R₆' is

9 -H, halogen, -CF₃, -OH, -NH₂, -SH, -CH₃, -Et, or acts as the functional equivalent of
10 H in the molecular recognition domain when bound to a TR,

11
12 wherein X is

13 O, S, SO₂, NH, NR₇, CH₂, CHR₇, CR₇R₇, wherein R₇ is alkyl, aryl or 5- or
14 6-membered heterocyclic aromatic,

15
16 and wherein said TR LBD ligand has an apparent K_d for binding TR LBD of 1 μM or less.

17
18 3. The method of claim 2, wherein

19 R₁ is carboxylate, phosphonate, phosphate or sulfite and is connected to the
20 ring with a 0 to 3 carbon linker,

21 R₂ is H,

22 R₃ is -I, -Br, or -CH₃,

23 R₅ is -I, -Br, or -CH₃,

1 R_6 is H,
2 R_2' is H,
3 R_3' is -I, -Br, -CH₃, -iPr, -phenyl, benzyl, or 5- or 6-membered ring
4 heterocycles,
5 R_4' is -OH, -NH₂, and -SH,
6 R_5' is -H, -OH, -NH₂, -N(CH₃)₂ -SH -NH₃, -N(CH₃)₃, carboxylate,
7 phosphonate, phosphate, sulfate, branched or straight chain alkyl having 1 to 9
8 carbons, substituted or unsubstituted aryl, wherein said substituted aryl is substituted
9 with halogen or 1 to 5 carbon alkyl and wherein said aryl is optionally connected to
10 the ring by a -CH₂-, aromatic heterocycle having 5 to 6 atoms, wherein said
11 heterocycle may be substituted with one or more groups selected from -OH, -NH₂, -
12 SH, -NH₃, -N(CH₃)₃, carboxylate, phosphonate, phosphate or sulfate, heteroalkyl,
13 arylalkyl, heteroaryl alkyl, polyaromatic, or polyheteroaromatic, wherein said R_5'
14 may be substituted with polar or charged groups, and
15 R_6' is H.
16

17 4. The method of claim 1, wherein said compound fits spatially and preferentially
18 into TR LBD isoform α (TR- α).
19

20 5. The method of claim 4, wherein said compound comprises an anionic group
21 that interacts with the side chain oxygen or carbon of a serine residue corresponding to
22 Ser277 of human TR- α , and wherein the anionic group is 1.7-4.0Å from the side chain atom.
23

1 6. The method of claim 1, wherein said compound fits spatially and preferentially
2 into TR LBD isoform β (TR- β).

3

4 7. The method of claim 6, wherein said compound comprises an anionic group
5 that interacts with the side chain nitrogen of an arginine corresponding to Asn331 of human
6 TR- β , and the anionic group is 1.7-4.0Å from the side chain atom.

7

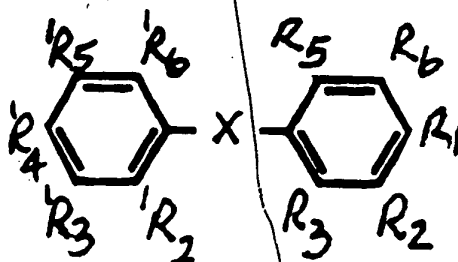
8 8. A method for identifying a compound capable of selectively modulating the
9 activity of a thyroid hormone receptor (TR) isoform, said method comprising:

10 modeling test compounds that fit spacially and preferentially into a TR ligand
11 binding domain (TR LBD) isoform of interest using an atomic structural model of a TR LBD
12 isoform bound to a test compound,

13 screening said test compounds in a biological assay for TR isoform activity
14 characterized by binding of a test compound to a TR LBD isoform, and

15 identifying a test compound that selectively modulates the activity of a TR
16 isoform.

17
18 9. The method of claim 8, wherein said compound is of the formula:



1 which comprises the following substituents:

2 (i) an R1-substituent comprising an anionic group that interacts with a side chain
3 nitrogen atom of an arginine corresponding to a residue selected from the group consisting of
4 Arg228, Arg262, and Arg266 of human TR- α , and Arg282, Arg316 and Arg320 of human
5 TR- β , and wherein the anionic group is 1.7-4.0Å from the nitrogen atom;

6 (ii) an R2-substituent comprising a hydrophobic or hydrophilic group that fits
7 spacially into the TR LBD;

8 (iii) an R3-substituent comprising a hydrophobic or hydrophilic group that
9 interacts with a side chain atom of a serine, alanine or isoleucine corresponding to a residue
10 selected from the group consisting of Ser260, Ala263 and Ile299 of human TR- α , and
11 Ser314, Ala317 and Ile352 of human TR- β , and wherein the hydrophobic or hydrophilic
12 group is 1.7-4.0Å from the side chain atom;

13 (iv) an R5-substituent comprising a hydrophobic or hydrophilic group that interacts
14 with a side chain atom of a phenylalanine or isoleucine corresponding to a residue selected
15 from the group consisting of Phe218, Ile221 and Ile222 of human TR- α , and Phe272, Ile275
16 and Ile276 of human TR- β , and wherein the hydrophobic or hydrophilic group is 1.7-4.0Å
17 from the side chain atom;

18 (v) an R6-substituent comprising a hydrophobic or hydrophilic group that fits
19 spacially into the TR LBD;

20 (vi) an X-substituent comprising a hydrophobic or hydrophilic group that interacts
21 with a side chain atom of a leucine corresponding to a residue selected from the group
22 consisting of Leu276 and Leu292 of human TR- α , and Leu 330 and Leu346 of human TR- β ,
23 and wherein the hydrophobic or hydrophilic group is 1.7-4.0Å from the side chain atom;

(vii) an R2'-substituent comprising a hydrophobic or hydrophilic group that fits spacially into the TR LBD;

(viii) an R3'-substituent comprising a hydrophobic group that interacts with a side chain atom of a phenylalanine, glycine or methionine corresponding to a residue selected from the group consisting of Phe215, Gly290, and Met388 of human TR- α , and Phe269, Gly344, Met442 of human TR- β , and wherein the hydrophobic group is 1.7-4.0Å from the side chain atom;

(ix) an R4'-substituent comprising an hydrogen bond donor or acceptor group that interacts with a side chain carbon or nitrogen atom of a histadine corresponding to residue His381 of human TR- α , and His435 of human TR- β , and wherein the hydrogen bond donor or acceptor group is 1.7-4.0Å from the side chain atom;

(x) an R5'-substituent comprising a hydrophobic or hydrophilic group that fits spacially into the TR LBD; and

(xi) and R6'-substituent comprising a hydrophobic or hydrophilic group that fits spacially into the TR LBD.

10. The method according to claim 9,

wherein R₁ is

-O-CH₂CO₂H, -NHCH₂CO₂H,

-CO₂H, -CH₂CO₂H, -CH₂CH₂CO₂H, -CH₂CH₂CH₂CO₂H,

-CH₂CH(NH₂)CO₂H, -CH₂CH[NHCOCH₂]₂CO₂H, -CH₂CH[NHCO(CH₂)₁₅CH₃

]CO₂H, -CH₂CH[NH-FMOC]CO₂H, -CH₂CH[NH-tBOC]CO₂H, or a carboxylate

connected to the ring with a 0 to 3 carbon linker,

1 -PO₃H₂, -CH₂PO₃H₂, -CH₂CH₂PO₃H₂, -CH₂CHNH₂PO₃H₂,

2 -CH₂CH[NHCOCH₂]₂PO₃H₂, -CH₂CH[NHCO(CH₂)₁₅CH₃]PO₃H₂,

3 -CH₂CH[NH-FMOC]PO₃H₂, -CH₂CH[NH-tBOC]PO₃H₂, or a phosphate or
4 phosphonate connected to the ring with a 0 to 3 carbon linker,

5
6 -SO₃H, -CH₂SO₃H, -CH₂CH₂SO₃H, -CH₂CHNH₂SO₃H, -CH₂CH[NHCOCH₂]₂SO₃H,

7 -CH₂CH[NHCO(CH₂)₁₅CH₃]SO₃H, -CH₂CH[NH-FMOC]SO₃H, -CH₂

8 CH[NH-tBOC]SO₃H, or a sulfate or sulfite connected to the ring with a 0 to 3 carbon
9 linker,

10
11 or acts as the functional equivalent of CH₂CH(NH₂)CO₂H of T3 in the molecular
12 recognition domain when bound to a TR, wherein said R₁ can be optionally
13 substituted with an amine,

14
15 wherein R₂ is

16 H, halogen, CF₃, OH, NH₂, SH, CH₃, -Et,

17 or acts as the functional equivalent of H in the molecular recognition domain when
18 bound to a TR,

19
20 wherein R₃ is

21 -H, halogen, -CF₃, -OH, -NH₂, -N₃, -SH, -CH₃, -Et,

22 or acts as the functional equivalent of I in the molecular recognition domain when
23 bound to a TR,

1 wherein R_5 is

2 -H, halogen, $-CF_3$, $-OH$, $-NH_2$, $-N_3$, $-SH$, $-CH_3$, $-Et$, or acts as the functional
3 equivalent of I in the molecular recognition domain when bound to a TR, and R_3 can
4 be identical to R_5 ,
5

6 wherein R_6 is

7 -H, halogen, $-CF_3$, $-OH$, $-NH_2$, $-SH$, $-CH_3$, or acts as the functional equivalent of H
8 in the molecular recognition domain when bound to a TR, and R_2 can be identical to
9 R_6 ,
10

11 wherein R_2' is

12 -H, halogen, $-CF_3$, $-OH$, $-NH_2$, $-N_3$, $-SH$, $-CH_3$, $-Et$, or acts as the functional
13 equivalent of H in the molecular recognition domain when bound to a TR,
14

15 wherein R_3' is any hydrophobic group, including

16 halogen, $-CF_3$, $-SH$, alkyl, aryl, 5- or 6-membered heterocyclic, cyano, or acts as the
17 functional equivalent of I in the molecular recognition domain when bound to a TR,
18

19 wherein R_4' is

20 -H, halogen, $-CF_3$, $-OH$, $-NH_2$, NH_3 , $-N(CH_3)_3$, carboxylate, phosphonate, phosphate
21 or sulfate, $-SH$, $-CH_3$, $-Et$, or alkyl, aryl or 5- or 6-membered heterocyclic aromatic
22 attached through urea or carbamate linkages to O or N or S at the R_4' position, or

1 acts as the functional equivalent of OH in the molecular recognition domain when
2 bound to a TR,

3
4 wherein R_5' is

5 -H, -OH, -NH₂, -N(CH₃)₂ -SH -NH₃, -N(CH₃)₃, carboxylate, phosphonate, phosphate,
6 sulfate, branched or straight chain alkyl having 1 to 9 carbons, substituted or
7 unsubstituted aryl, wherein said substituted aryl is substituted with halogen or 1 to 5
8 carbon alkyl and wherein said aryl is optionally connected to the ring by a -CH₂-,
9 aromatic heterocycle having 5 to 6 atoms, wherein said heterocycle may be substituted
10 with one or more groups selected from -OH, -NH₂, -SH, -NH₃, -N(CH₃)₃,
11 carboxylate, phosphonate, phosphate or sulfate, heteroalkyl, arylalkyl, heteroaryl
12 alkyl, polyaromatic, or polyheteroaromatic, wherein said R_5' may be substituted with
13 polar or charged groups,

14
15 wherein R_6' is

16 -H, halogen, -CF₃, -OH, -NH₂, -SH, -CH₃, -Et, or acts as the functional equivalent of
17 H in the molecular recognition domain when bound to a TR,

18
19 wherein X is

20 O, S, SO₂, NH, NR₇, CH₂, CHR₇, CR₇R₇, wherein R₇ is alkyl, aryl or 5- or
21 6-membered heterocyclic aromatic,

22
23 and wherein said TR LBD ligand has an apparent K_d for binding TR LBD of 1 μ M or less.

11. The method of claim 10, wherein

R_1 is carboxylate, phosphonate, phosphate or sulfite and is connected to the ring with a 0 to 3 carbon linker,

R_2 is H,

R_3 is -I, -Br, or -CH₃,

R_5 is -I, -Br, or -CH₃,

R_6 is H,

R_2' is H,

R_3' is -I, -Br, -CH₃, -iPr, -phenyl, benzyl, or 5- or 6-membered ring heterocycles,

R_4' is -OH, -NH₂, and -SH,

R_5' is -H, -OH, -NH₂, -N(CH₃)₂, -SH, -NH₃, -N(CH₃)₃, carboxylate, phosphonate, phosphate, sulfate, branched or straight chain alkyl having 1 to 9 carbons, substituted or unsubstituted aryl, wherein said substituted aryl is substituted with halogen or 1 to 5 carbon alkyl and wherein said aryl is optionally connected to the ring by a -CH₂-, aromatic heterocycle having 5 to 6 atoms, wherein said heterocycle may be substituted with one or more groups selected from -OH, -NH₂, -SH, -NH₃, -N(CH₃)₃, carboxylate, phosphonate, phosphate or sulfate, heteroalkyl, arylalkyl, heteroaryl alkyl, polyaromatic, or polyheteroaromatic, wherein said R_5' may be substituted with polar or charged groups, and

R_6' is H.

1 12. The method of claim 8, wherein said compound fits spatially and preferentially
2 into TR LBD isoform α (TR- α).
3

4 13. The method of claim 12, wherein said compound comprises an anionic group
5 that interacts with the side chain oxygen or carbon of a serine residue corresponding to
6 Ser277 of human TR- α , and wherein the anionic group is 1.7-4.0Å from the side chain atom.
7

8 14. The method of claim 8, wherein said compound fits spatially and preferentially
9 into TR LBD isoform β (TR- β).
10

11 15. The method of claim 14, wherein said compound comprises an anionic group
12 that interacts with the side chain nitrogen of an arginine corresponding to Asn331 of human
13 TR- β , and the anionic group is 1.7-4.0Å from the side chain atom.
14

15 16. The method of claim 8, wherein said compound binds to a TR LBD isoform
16 with greater affinity than thyronine or triiodothyronine.
17

18 17. A method for identifying a thyroid hormone receptor (TR) agonist or
19 antagonist ligand, said method comprising the steps of:
20 providing the atomic coordinates of a TR ligand binding domain (TR LBD) to
21 a computerized modeling system;
22 modeling ligands which fit spacially into the TR LBD; and

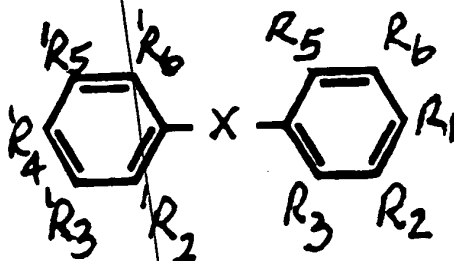
1 identifying in a biological assay for TR activity a ligand which increases or
2 decreases the activity of said TR, whereby a TR agonist or antagonist is identified.

3
4 *Sub 18* 18. A peptide, peptidomimetic or synthetic molecule identified by the method of
5 any one of claims 8 or 17, with the proviso that said molecule is other than a thyronine or
6 thyronine-like compound disclosed in a reference cited in Appendix I.

7
8 19. A method of identifying a compound that selectively modulates the activity of
9 a thyroid hormone receptor (TR) compared to other nuclear hormone receptors, said method
10 comprising:
11 modeling compounds which fit spacially into a TR ligand binding domain (TR
12 LBD) using an atomic structural model of a TR LBD,
13 selecting a compound comprising conformationally constrained structural
14 features that interact with conformationally constrained residues of a TR LBD,
15 identifying in a biological assay for TR activity a compound that selectively
16 binds to a TR LBD compared to other nuclear receptors, whereby a compound that
17 selectively modulates a TR is identified

18
19 20. The method of claim 19, wherein said conformationally constrained residues of
20 a TR LBD correspond to residues Met259, Leu276, Leu292, His381, Gly290, Ile221, and
21 Phe401 of human TR- α , and residues Met313, Leu330, Leu346, His435, Gly344, Ile275 and
22 Phe455 of human TR- β .

21. The method of claim 19, wherein said compounds are of the formula:



which comprises the following substituents:

(i) an R₁-substituent comprising an anionic group that interacts with a side chain nitrogen atom of an arginine corresponding to a residue selected from the group consisting of Arg228, Arg262, and Arg266 of human TR- α , and Arg282, Arg316 and Arg320 of human TR- β , and wherein the anionic group is 1.7-4.0Å from the nitrogen atom;

(ii) an R₂-substituent comprising a hydrophobic or hydrophilic group that fits spacially into the TR LBD;

(iii) an R₃-substituent comprising a hydrophobic or hydrophilic group that interacts with a side chain atom of a serine, alanine or isoleucine corresponding to a residue selected from the group consisting of Ser260, Ala263 and Ile299 of human TR- α , and Ser314, Ala317 and Ile352 of human TR- β , and wherein the hydrophobic or hydrophilic group is 1.7-4.0Å from the side chain atom;

(iv) an R₅-substituent comprising a hydrophobic or hydrophilic group that interacts with a side chain atom of a phenylalanine or isoleucine corresponding to a residue selected from the group consisting of Phe218, Ile221 and Ile222 of human TR- α , and Phe272, Ile275

1 and Ile276 of human TR- β , and wherein the hydrophobic or hydrophilic group is 1.7-4.0Å
2 from the side chain atom;

3 (v) an R6-substituent comprising a hydrophobic or hydrophilic group that fits
4 spacially into the TR LBD;

5 (vi) an X-substituent comprising a hydrophobic or hydrophilic group that interacts
6 with a side chain atom of a leucine corresponding to a residue selected from the group
7 consisting of Leu276 and Leu292 of human TR- α , and Leu 330 and Leu346 of human TR- β ,
8 and wherein the hydrophobic or hydrophilic group is 1.7-4.0Å from the side chain atom;

9 (vii) an R2'-substituent comprising a hydrophobic or hydrophilic group that fits
10 spacially into the TR LBD;

11 (viii) an R3'-substituent comprising a hydrophobic group that interacts with a side
12 chain atom of a phenylalanine, glycine or methionine corresponding to a residue selected
13 from the group consisting of Phe215, Gly290, and Met388 of human TR- α , and Phe269,
14 Gly344, Met442 of human TR- β , and wherein the hydrophobic group is 1.7-4.0Å from the
15 side chain atom;

16 (ix) an R4'-substituent comprising an hydrogen bond donor or acceptor group that
17 interacts with a side chain carbon or nitrogen atom of a histidine corresponding to residue
18 His381 of human TR- α , and His435 of human TR- β , and wherein the hydrogen bond donor
19 or acceptor group is 1.7-4.0Å from the side chain atom;

20 (x) an R5'-substituent comprising a hydrophobic or hydrophilic group that fits
21 spacially into the TR LBD; and

22 (xi) and R6'-substituent comprising a hydrophobic or hydrophilic group that fits
23 spacially into the TR LBD.

1 22. The method of claim 19, wherein said compound comprises:

2 (i) a cyclic carbon atom that interacts with a carbon and oxygen atom of a

3 methionine residue corresponding to Met259 of human TR- α , and Met313 of human TR- β ,

4 wherein the cyclic carbon is about 3.0 to 4.0Å from the carbon and oxygen atom of the

5 methionine;

6 (ii) a cyclic carbon atom that interacts with a carbon atom of a leucine residue

7 corresponding to Leu276 of human TR- α , and Leu330 of human TR- β , wherein the cyclic

8 carbon is about 3.0 to 4.0Å from the carbon atom of the leucine;

9 (iii) a cyclic carbon atom that interacts with a carbon atom of a leucine residue

10 corresponding to Leu292 of human TR- α , and Leu346 of human TR- β , wherein the cyclic

11 carbon is about 3.0 to 4.0Å from the carbon atom of the leucine;

12 (iv) a R3-substituent comprising an atom that interacts with a carbon atom of an

13 isoleucine residue corresponding to Ile221 of human TR- α , and Ile275 of human TR- β ,

14 wherein the R3-substituent atom is about 3.0 to 4.0Å from the carbon atom of the isoleucine;

15 (v) a R3'-substituent comprising an atom that interacts with an oxygen atom of a

16 glycine residue corresponding to Gly290 of human TR- α , and Gly344 of human TR- β ,

17 wherein the R3'-substituent atom is about 3.0 to 4.0Å from the carbon atom of the glycine;

18 and

19 (vi) a R4'-substituent comprising an atom selected from the group consisting of

20 oxygen and carbon that interacts with (a) a carbon and nitrogen atom of a histidine residue

21 corresponding to His381 of human TR- α , and His435 of human TR- β , wherein the R4'-

22 substituent atom is about 2.0 to 4.0Å from the carbon atom of the histidine; and (b) a carbon

23 atom of a phenylalanine residue corresponding to Phe401 of human TR- α , and human

1 Phe455 of TR- β , wherein said atom is about 3.0 to 4.0Å from the carbon atom of the
2 phenylalanine.

3
4 23. The method according to claim 21,

5 wherein R₁ is

6 -O-CH₂CO₂H, -NHCH₂CO₂H,

7 -CO₂H, -CH₂CO₂H, -CH₂CH₂CO₂H, -CH₂CH₂CH₂CO₂H,

8 -CH₂CH(NH₂)CO₂H, -CH₂CH[NHCOCH ϕ ₂]CO₂H, -CH₂CH[NHCO(CH₂)₁₅CH₃,

9]CO₂H, -CH₂CH[NH-FMOC]CO₂H, -CH₂CH[NH-tBOC]CO₂H, or a carboxylate

10 connected to the ring with a 0 to 3 carbon linker,

11
12 -PO₃H₂, -CH₂PO₃H₂, -CH₂CH₂PO₃H₂, -CH₂CHNH₂PO₃H₂,

13 -CH₂CH[NHCOCH ϕ ₂]PO₃H₂, -CH₂CH[NHCO(CH₂)₁₅CH₃]PO₃H₂,

14 -CH₂CH[NH-FMOC]PO₃H₂, -CH₂CH[NH-tBOC]PO₃H₂, or a phosphate or

15 phosphonate connected to the ring with a 0 to 3 carbon linker,

16
17 -SO₃H, -CH₂SO₃H, -CH₂CH₂SO₃H, -CH₂CHNH₂SO₃H, -CH₂CH[NHCOCH ϕ ₂]SO₃H,

18 -CH₂CH[NHCO(CH₂)₁₅CH₃]SO₃H, -CH₂CH[NH-FMOC]SO₃H, -CH₂

19 CH[NH-tBOC]SO₃H, or a sulfate or sulfite connected to the ring with a 0 to 3 carbon

20 linker,

1 or acts as the functional equivalent of $\text{CH}_2\text{CH}(\text{NH}_2)\text{CO}_2\text{H}$ of T3 in the molecular
2 recognition domain when bound to a TR, wherein said R_1 can be optionally
3 substituted with an amine,
4

5 wherein R_2 is

6 H, halogen, CF_3 , OH, NH_2 , SH, CH_3 , -Et,

7 or acts as the functional equivalent of H in the molecular recognition domain when
8 bound to a TR,
9

10 wherein R_3 is

11 -H, halogen, $-\text{CF}_3$, -OH, $-\text{NH}_2$, $-\text{N}_3$, -SH, $-\text{CH}_3$, -Et,

12 or acts as the functional equivalent of I in the molecular recognition domain when
13 bound to a TR,
14

15 wherein R_5 is

16 -H, halogen, $-\text{CF}_3$, -OH, $-\text{NH}_2$, $-\text{N}_3$, -SH, $-\text{CH}_3$, -Et, or acts as the functional
17 equivalent of I in the molecular recognition domain when bound to a TR, and R_3 can
18 be identical to R_5 ,
19

20 wherein R_6 is

21 -H, halogen, $-\text{CF}_3$, -OH, $-\text{NH}_2$, -SH, $-\text{CH}_3$, or acts as the functional equivalent of H
22 in the molecular recognition domain when bound to a TR, and R_2 can be identical to
23 R_6 ,

1 wherein R_2' is

2 -H, halogen, $-CF_3$, $-OH$, $-NH_2$, $-N_3$, $-SH$, $-CH_3$, $-Et$, or acts as the functional
3 equivalent of H in the molecular recognition domain when bound to a TR,
4

5 wherein R_3' is any hydrophobic group, including

6 halogen, $-CF_3$, $-SH$, alkyl, aryl, 5- or 6-membered heterocycle, cyano, or acts as the
7 functional equivalent of I in the molecular recognition domain when bound to a TR,
8

9 wherein R_4' is

10 -H, halogen, $-CF_3$, $-OH$, $-NH_2$, NH_3 , $-N(CH_3)_3$, carboxylate, phosphonate, phosphate
11 or sulfate, $-SH$, $-CH_3$, $-Et$, or alkyl, aryl or 5- or 6-membered heterocyclic aromatic
12 attached through urea or carbamate linkages to O or N or S at the R_4' position, or
13 acts as the functional equivalent of OH in the molecular recognition domain when
14 bound to a TR,
15

16 wherein R_5' is

17 -H, $-OH$, $-NH_2$, $-N(CH_3)_2$, $-SH$, $-NH_3$, $-N(CH_3)_3$, carboxylate, phosphonate, phosphate,
18 sulfate, branched or straight chain alkyl having 1 to 9 carbons, substituted or
19 unsubstituted aryl, wherein said substituted aryl is substituted with halogen or 1 to 5
20 carbon alkyl and wherein said aryl is optionally connected to the ring by a $-CH_2-$,
21 aromatic heterocycle having 5 to 6 atoms, wherein said heterocycle may be substituted
22 with one or more groups selected from $-OH$, $-NH_2$, $-SH$, $-NH_3$, $-N(CH_3)_3$,
23 carboxylate, phosphonate, phosphate or sulfate, heteroalkyl, arylalkyl, heteroaryl

1 alkyl, polyaromatic, or polyheteroaromatic, wherein said R_5' may be substituted with
2 polar or charged groups,

3

4 wherein R_6' is

5 -H, halogen, $-CF_3$, $-OH$, $-NH_2$, $-SH$, $-CH_3$, $-Et$, or acts as the functional equivalent of
6 H in the molecular recognition domain when bound to a TR,

7

8 wherein X is

9 O, S, SO_2 , NH, NR_7 , CH_2 , CHR_7 , CR_7R_7 , wherein R_7 is alkyl, aryl or 5- or
10 6-membered heterocyclic aromatic,

11

12 and wherein said TR LBD ligand has an apparent K_d for binding TR LBD of 1 μM or less.

13

14 24. The method of claim 23, wherein

15 R_1 is carboxylate, phosphonate, phosphate or sulfite and is connected to the
16 ring with a 0 to 3 carbon linker,

17

R_2 is H,

18

R_3 is -I, -Br, or $-CH_3$,

19

R_5 is -I, -Br, or $-CH_3$,

20

R_6 is H,

21

R_2' is H,

22

R_3' is -I, -Br, $-CH_3$, -iPr, -phenyl, benzyl, or 5- or 6-membered ring

23 heterocycles,

1 R₄' is -OH, -NH₂, and -SH,

2 R₅' is -H, -OH, -NH₂, -N(CH₃)₂ -SH -NH₃, -N(CH₃)₃, carboxylate,
3 phosphonate, phosphate, sulfate, branched or straight chain alkyl having 1 to 9
4 carbons, substituted or unsubstituted aryl, wherein said substituted aryl is substituted
5 with halogen or 1 to 5 carbon alkyl and wherein said aryl is optionally connected to
6 the ring by a -CH₂-, aromatic heterocycle having 5 to 6 atoms, wherein said
7 heterocycle may be substituted with one or more groups selected from -OH, -NH₂, -
8 SH, -NH₃, -N(CH₃)₃, carboxylate, phosphonate, phosphate or sulfate, heteroalkyl,
9 arylalkyl, heteroaryl alkyl, polyaromatic, or polyheteroaromatic, wherein said R₅'
10 may be substituted with polar or charged groups, and

11 R₆' is H.

12
13 25. The method of claim 19, wherein said compound fits spatially and
14 preferentially into TR LBD isoform α (TR- α).

15
16 26. The method of claim 25, wherein said compound comprises an anionic group
17 that interacts with the side chain oxygen or carbon of a serine residue corresponding to
18 Ser277 of human TR- α , and wherein the anionic group is 1.7-4.0Å from the side chain atom.

19
20 27. The method of claim 19, wherein said compound fits spatially and
21 preferentially into TR LBD isoform β (TR- β).

1 28. The method of claim 27, wherein said compound comprises an anionic group
2 that interacts with the side chain nitrogen of an arginine corresponding to Asn331 of human
3 TR- β , and the anionic group is 1.7-4.0Å from the side chain atom.

4
5 29. The method of claim 19, wherein said compound binds to a TR LBD isoform
6 with greater affinity than thyronine or triiodothyronine.

7
8 30. The method of claim 1, wherein said compound comprises a cyclic carbon
9 atom that interacts with a carbon and oxygen atom of a methionine residue corresponding to
10 Met259 of human TR- α , and Met313 of human TR- β , wherein the cyclic carbon is about 3.0
11 to 4.0Å from the carbon and oxygen atom of the methionine.

12
13 31. The method of claim 30, wherein said cyclic carbon is inner ring carbon C11.

14
15 32. The method of claim 1, wherein said compound comprises a cyclic carbon
16 atom that interacts with a carbon atom of a leucine residue corresponding to Leu276 of
17 human TR- α , and Leu330 of human TR- β , wherein the cyclic carbon is about 3.0 to 4.0Å
18 from the carbon atom of the leucine.

19
20 33. The method of claim 32, wherein said cyclic carbon is selected from the group
21 consisting of inner ring carbons C7 and C9.

1 34. The method of claim 1, wherein said compound comprises a cyclic carbon
2 atom that interacts with a carbon atom of a leucine residue corresponding to Leu292 of
3 human TR- α , and Leu346 of human TR- β , wherein the cyclic carbon is about 3.0 to 4.0Å
4 from the carbon atom of the leucine.

5
6 35. The method of claim 34, wherein said cyclic carbon is selected from the group
7 consisting of outer ring carbons C6 and C8.

8
9 36. The method of claim 1, wherein said R3-substituent comprises an atom that
10 interacts with a carbon atom of an isoleucine residue corresponding to Ile221 of human TR-
11 α , and Ile275 of human TR- β , wherein the R3-substituent atom is about 3.0 to 4.0Å from the
12 carbon atom of the isoleucine.

13
14 37. The method of claim 1, wherein said R3'-substituent comprises an atom that
15 interacts with an oxygen atom of a glycine residue corresponding to Gly290 of human TR- α ,
16 and Gly344 of human TR- β , wherein the R3'-substituent atom is about 3.0 to 4.0Å from the
17 carbon atom of the glycine.

18
19 38. The method of claim 1, wherein said R4'-substituent comprises an atom
20 selected from the group consisting of oxygen and carbon that interacts with a carbon and
21 nitrogen atom of a histidine residue corresponding to His381 of human TR- α , and His435 of
22 human TR- β , wherein the R4'-substituent atom is about 2.0 to 4.0Å from the carbon atom of
23 the histidine.

1 39. The method of claim 1, wherein said R4'-substituent comprises an oxygen
2 atom that interacts with a carbon atom of a phenylalanine residue corresponding to Phe401 of
3 human TR- α , and human Phe455 of TR- β , wherein said atom is about 3.0 to 4.0Å from the
4 carbon atom of the phenylalanine.

5
6 40. A method for identifying a thyroid hormone receptor (TR) agonist or
7 antagonist ligand that selectively modulates the activity of a TR compared to other nuclear
8 receptors, said method comprising the steps of:

9 providing the atomic coordinates of a TR ligand binding domain (TR LBD) to
10 a computerized modeling system;

11 modeling ligands which fit spacially into the TR LBD and which interact with
12 conformationally constrained residues of a TR LBD conserved among TR isoforms; and

13 identifying in a biological assay for TR activity a ligand which selectively
14 binds to said TR and increases or decreases the activity of said TR, whereby a TR agonist or
15 antagonist that selectively modulates the activity of a TR is identified.
16

Sub 75
17 41. A peptide, peptidomimetic or synthetic molecule identified by the method of any
18 one of claims 19 or 40, with the proviso that said molecule is other than a thyronine or
19 thyronine-like compound disclosed in a reference cited in Appendix I.

20
21 42. A machine-readable data storage medium, comprising a data storage material
22 encoded with machine readable data which, when using a machine programmed with
23 instructions for using said data, is capable of displaying a graphical three-dimensional

1 representation of a molecule or molecular complex for a thyroid hormone ligand binding
2 pocket comprising structure coordinates of TR- α amino acids corresponding to human TR- α
3 amino acids Met259, Leu276, and Ile221, or a homologue of said molecule or molecular
4 complex, wherein said homologue comprises a binding pocket that has a root mean square
5 deviation from the backbone atoms of said amino acids of not more than 1.5Å.

6
7 43. A machine-readable data storage medium, comprising a data storage material
8 encoded with machine readable data which, when using a machine programmed with
9 instructions for using said data, is capable of displaying a graphical three-dimensional
10 representation of a molecule or molecular complex for a thyroid hormone ligand binding
11 pocket comprising structure coordinates of TR- α amino acids corresponding to human TR- α
12 amino acids Leu292, His381, Gly290 and Phe401, or a homologue of said molecule or
13 molecular complex, wherein said homologue comprises a binding pocket that has a root mean
14 square deviation from the backbone atoms of said amino acids of not more than 1.5Å.

15
16 44. The machine-readable storage medium according to any one of claims 42 or
17 43, wherein said binding pocket comprises structure coordinates of TR- α amino acids
18 corresponding to human TR- α amino acids Met259, Leu276, Leu292, His381, Gly290,
19 Ile221 and Phe401.

20
21 45. The machine-readable storage medium according to claim 44, wherein said
22 binding pocket comprises structure coordinates of TR- α amino acids corresponding to human
23 TR- α amino acids Arg228, Arg262 and Arg266.

1 46. The machine-readable storage medium according to claim 44, wherein said
2 binding pocket comprises structure coordinates of TR- α amino acids corresponding to human
3 TR- α amino acids Ser260, Ala263 and Ile299.

4
5 47. The machine-readable storage medium according to claim 44, wherein said
6 binding pocket comprises structure coordinates of TR- α amino acids corresponding to human
7 TR- α amino acids Phe218, Ile221 and Ile222.

8
9 48. The machine-readable storage medium according to claim 44, wherein said
10 binding pocket comprises structure coordinates of TR- α amino acids corresponding to human
11 TR- α amino acids Phe215, Gly290 and Met388.

12
13 49. The machine-readable storage medium according to claim 44, wherein said
14 binding pocket comprises structure coordinates of a TR- α amino acid corresponding to
15 human TR- α amino acid Ser277.

16
17 50. A machine-readable data storage medium, comprising a data storage material
18 encoded with machine readable data which, when using a machine programmed with
19 instructions for using said data, is capable of displaying a graphical three-dimensional
20 representation of a molecule or molecular complex for a thyroid hormone ligand binding
21 pocket comprising structure coordinates of TR- β amino acids corresponding to human TR- β
22 amino acids Met313, Leu330, and Ile275, or a homologue of said molecule or molecular

1 complex, wherein said homologue comprises a binding pocket that has a root mean square
2 deviation from the backbone atoms of said amino acids of not more than 1.5Å.

3
4 51. A machine-readable data storage medium, comprising a data storage material
5 encoded with machine readable data which, when using a machine programmed with
6 instructions for using said data, is capable of displaying a graphical three-dimensional
7 representation of a molecule or molecular complex for a thyroid hormone ligand binding
8 pocket comprising structure coordinates of TR- β amino acids corresponding to human TR- β
9 amino acids Leu346, His435, Gly344, and Phe455, or a homologue of said molecule or
10 molecular complex, wherein said homologue comprises a binding pocket that has a root mean
11 square deviation from the backbone atoms of said amino acids of not more than 1.5Å.

12
13 52. The machine-readable data storage medium according to any one of claims 50
14 or 51, wherein said binding pocket comprises structure coordinates of TR- β amino acids
15 corresponding to human TR- β amino acids Met313, Leu330, Leu346, His435, Gly344,
16 Ile275 and Phe455.

17
18 53. The machine-readable data storage medium according to claim 52, wherein
19 said binding pocket comprises structure coordinates of TR- β amino acids corresponding to
20 human TR- β amino acids Arg282, Arg316 and Arg320.

1 54. The machine-readable data storage medium according to claim 52, wherein
2 said binding pocket comprises structure coordinates of TR- β amino acids corresponding to
3 human TR- β amino acids Ser314, Ala317 and Ile352.

4
5 55. The machine-readable data storage medium according to claim 52, wherein
6 said binding pocket comprises structure coordinates of TR- β amino acids corresponding to
7 human TR- β amino acids Phe272, Ile275 and Ile276.

8
9 56. The machine-readable data storage medium according to claim 52, wherein
10 said binding pocket further comprises structure coordinates of TR- β amino acids
11 corresponding to human TR- β amino acids Phe269, Gly344 and Met442.

12
13 57. The machine-readable data storage medium according to claim 52, wherein
14 said binding pocket comprises structure coordinates of a TR- β amino acid corresponding to
15 human TR- β amino acid Asn331.

16
17 58. The machine-readable data storage medium according to claim 52, wherein
18 said molecule or molecular complex is defined by the set of structure coordinates selected
19 from the group consisting coordinates depicted in Appendix 3, 4, 5 and 6, or a homologue of
20 said molecule or molecular complex, said homologue having a root mean square deviation
21 from the backbone atoms of said amino acids of not more than 1.5Å.

